ET Docket Number 03-104

In the matter of

Inquiry Regarding Carrier Current Systems,
Including Broadband over Power Line Systems

Comments of Courtney B. Duncan:

1. I applaud The Commission's policy to improve and extend broadband digital access to as much of the public as possible. In particular I support The Commission's interest in the utilization of diverse, competitive technologies to provide such services. The desire to enfranchise those near the fringes of electronic society, such as those in rural settings, is commendable.

2. Not all possible access models and technologies are created equal, however. Just because, for example, we are technically capable of draining sewage from our homes and businesses into street gutters does not mean that we as a society want to modify sanitation regulations to set up a competitive industry of sewage handling where tenants have a choice between piped sewage or gutter borne open air sewage, the choice driven solely by market forces.

3. The breadth and scope of the questions posed by The Commission in this Notice of Inquiry indicate that any attempt to define, regulate or deploy a Broadcast over Power Line (BPL) service at this point, particularly Access BPL, is vastly premature. Transmission modes, modulation schemes, security measures, and media sharing techniques are but a few of the many important issues on which discussion is apparently only now beginning.

4. My remarks will not address specific Commission questions, therefore, but will qualitatively discuss several problems posed by BPL as envisioned.

5. There is the problem of inadequate bandwidth. If all frequencies, zero through 50 MHz are utilized to the fullest extent of existing technology, only several tens of Mbps can be available to be shared by all users in a particular BPL locality. The Commission has witnessed an impressive demonstration of the potential of BPL technology in a setting which included simultaneous high speed internet access for multiple uses and simultaneous printing in another room, with performance apparently equivalent to existing T-10 and T-100 networks. This is presumably near the limit of existing BPL technology. If this demonstration were conducted in an office or apartment building where ten or twenty similarly equipped offices or residences shared the same power transformer it is doubtful that any one user's In House BPL performance could be adequate. Even if it is adequate today, it will not be in the near future as bandwidth demands grow. There is no new technology on the

horizon that will substantially increase the high-speed data capacity of an existing power line.

6. If there were no other problems, BPL might be stillborn for this reason alone, after much investment.

7. The applications envisioned will require Class A conducted emission limits for In House BPL devices. A commercial or business office environment is clearly indicated.

8. There is the problem of interference to existing licensed services in the bandwidth used. In both In House BPL and Access BPL, particularly in Access BPL, the BPL signals are not contained within coax or fiber, rather they are carried, possibly for great distances, over open wires which serve as respectable if not excellent antennas at medium frequency, high frequency, and very high frequency ranges. Regardless of the mode of introduction of BPL signals into this media, there will be significant, unintended radiation over the air.

9. In my home amateur radio installation I have a modest dipole antenna, ten meters in length, located approximately thirty meters from a residential power line. Any in-band signal of more than a fraction of one micro-volt which reaches my receiver, that is, a fraction of a tenth of a microvolt per meter impinging on my antenna from that power line, will cause degradation in receive performance with respect to the intended receive function which is to discern and demodulate signals as close to natural noise levels as possible. This, in turn, will require the station I am attempting to receive to use higher power to continue the communication, or will make that communication impossible. Further, my license grant permits me to use up to one thousand watts transmitter power if needed which can induce several volts per meter back on the power line.

10. Amateurs routinely communicate over great distances via sky wave (refraction from the ionosphere) using surprisingly low power levels both as a test of capability and for the challenge of demonstrating what can be done. This is one of their principal means of conducting emergency and disaster relief operations when other communications infrastructure options are incapacitated. If an amateur could couple one watt of radio frequency power into a typical residential power line in order to use it as an intentional antenna he or she could easily communicate with, and therefore interfere with another station across the country or in another country thousands of miles away. BPL may not operate at this power level, but will still be detectable at great distances, given favorable propagation conditions, which are not uncommon.

11. Inasmuch as my home amateur station is modest and conservatively representative of communications situations such as any short wave broadcast

listener, various military and government installations, or a public safety vehicle parked or traveling under a power line, The Commission must institute radiated emission standards which guarantee that these existing licensed over-the-air services are not degraded. Also, BPL equipment manufacturers will want to ensure that their services and equipment are not degraded by induced signal levels of several volts on shared frequencies.

12. To this end, I recommend field testing with a representative power pole and power line wherein BPL equipment test articles conducting their signals over the power lines are shown not to exceed certain radiation limits such as 1 microvolt per meter measured directly under the power line, 10 meters below the wires. The equipment's resistance to susceptibility should be such that they operate satisfactorily when power levels of at least a hundred watts are transmitted from directly beneath the lines.

13. BPL systems in order to do their job will be constant carrier, that is, they will be introducing radio frequency energy into the power lines most or all of the time, unlike the occasional devices like lamp control devices or power line telemetry mentioned in the Notice of Inquiry. Also, in order to achieve broad bandwidths, they will need to fill the utilized spectrum with energy, regardless of the modulation scheme used. This implies that if the radiated emission and susceptibility limits in paragraph 11 cannot be met, frequency sharing is required, that is, BPL services will need to be allocated spectrum only where their unintended over-the-air transmission is permissible so as not to degrade performance in existing over-the-air services.

14. Such operation could be accommodated in the existing ISM bands but the ISM bandwidth available in the frequency range of interest is tiny compared to broad band digital bandwidth requirements.

15. The apparent high degree of compatibility between existing BPL-like devices and existing over the air services now may be much poorer than is perceived based on complaints and interference resolution reports. In my amateur installation, I occasionally experience broadband noise interference on the 14, 18, and/or 21 MHz amateur bands at a signal strengths comparable to a very strong legitimate transmitting station, that is, several millivolts to my receiver in the small bandwidth of interest. My home is surrounded by other residences, perhaps a dozen within a suitable range where a malfunctioning appliance, or someone using their in-house power line data network for a few hours, could cause this sort of interference. Some of my neighbors would be open to a thorough inspection of their home and all electronics within it that I might initiate in a search for the offending radiator and others would not. Even if I locate the actual device, will it have a phone number printed on it where I can call the manufacturer for help in interference resolution? None of my own appliances and electronic devices have such markings on them.

16. Many users of existing over-the-air services, such as peace officers, will not be as technically savvy or aware of the sources of new trouble with their communication systems as I might be in this situation. Should they wish to complain about their degraded service, how will they do so? Some might know enough to phone the nearest FCC Field Office. Others might just call the police, confront their neighbor who may or may not be at fault, or just abandon their own malfunctioning equipment. Since the envisioned In House BPL and Access BPL systems will increase the amount of this interference by several orders of magnitude, The Commission should prepare for several orders of magnitude increases in complaints and problem resolution work.

17. To the extent that other services sharing utility poles or right of ways, such as cable TV and telephone, are installed and maintained to standards, a BPL system which meets the radiated emissions and susceptibility stated in paragraph 11 will coexist without problem. Such systems are not always installed and maintained in good working order, however, nor are the power distribution networks themselves. Maintenance response across the country as experienced, for example, by amateur radio operators with respect to power line arcing or cable leakage is quite varied. The advent of another communications utility in the easement will expose additional maintenance problems, both technical and institutional, another potential source for vastly increased Commission workload.

18. Finally, there is the problem of safety. Utility power distribution systems were not conceived, designed, or implemented to carry anything but power to end customers, often at high voltages and currents and often over great distances. Any attempt to make additional use of this network such as Access BPL must be undertaken with the greatest care with respect both to installation safety and electronic and electromagnetic consequences discussed above.

19. It appears that any design for Access BPL will require special equipment to bridge the BPL signals around transformers and that connection between Access BPL and In House BPL can require a bridge around the service breaker panel. Any such bridging devices will need to be designed for electrical safety during installation, operation, and in case of failure and certified as such, for example, by Underwriters Laboratories (UL). A failing BPL devices must not short around the transformer or breaker box, or short them directly or expose anyone to electrical danger. When a fault occurs, for instance, within a home or business which causes breakers in the breaker panel to trip, any bridging BPL device must honor the open circuit and not create a safety hazard by conducting around the panel or through some mechanism of its own destruction. The utilities that maintain the lines, poles, and service drops will doubtless have additional concerns and requirements, safety, revenue, and liability among them.

20. In implementing Access BPL over even a modest area, thousands of transformer bridges will need to be installed. This will require teams of skilled service personnel hundreds of hours of hazardous duty. The installed equipment must then be robust and must fail in ways that are not hazardous to workers or utility customers. The costs of implementing and maintaining such a network may not be as low as The Commission or The Consortium imagine. The cost uncertainty on safety and liability issues is potentially large.

21. As broad band technology is developed nationwide, The Commission is understandably eager to promote and enable this historic, democratic force in society. Not all possible access models and technologies are created equal, however. The analogy bears repeating. Just because we are capable of draining sewage from our homes and businesses into street gutters does not mean that we as a society want to modify sanitation regulations to set up a competitive industry of sewage handling where tenants have a price or convenience driven choice between piped sewage and open air sewage. Recent historic developments such as the California power crises of 2001 where a widely acclaimed and legislatively unanimously approved power marketing system was distorted into a major and costly debacle and setback for an entire industry provide a cautionary chronicle. Inasmuch as physics does not yield to political and marketing forces, be very careful in picking which broad band schemes to encourage widely. BPL could be the next Cold Fusion and the political and economic costs to The Commission and the nation could be great.

22. It may be the implicit view of The Commission that existing users of the medium frequency, high frequency and very high frequency bands are anachronistic, should ultimately be phased out, and should in any case take a back seat to new technological developments such as BPL. While these are issues that should be debated separately from this proceeding, I would caution that the BPL technology proposed here will make those bands of frequencies useless for any future shared usage, some of which may be unique capabilities of those bands, such as sky-wave propagation. This is reminiscent of a proposal in the early 60s to enhance long distance radio communications by placing thousands of dipoles in earth orbit to act as passive re-radiators. While this may have worked from the perspective of the radio users, all those dipoles in orbit would have made near earth space unusable for any other exploratory or research purpose until they could be naturally or intentionally removed, setting back the space programs of the world perhaps ten or twenty years or longer. Access BPL could have the same sort of deleterious effects on the spectrum used.

23. Also, keep in mind that in times of widespread distress, it is often low-tech solutions and facilities that provide what little relief that remains available. When a terrorist attack takes down a large part of the power grid, all of the BPL services will go with it but some independently configured amateur radio

and public safety installations will still be operational, at least in a limited sense.

24. Despite the possible limitations, hazards, and costs of BPL, it does appear to be one possible contributor to near-universal wideband access and I again applaud The Commission for its encouraging and light-handed regulatory stance on such emerging technologies. Take great care, however, in ensuring that installed systems are safe, are really capable of delivering on their promise, and do not degrade existing, licensed over-the-air radio services and do not thwart legitimate future technologies.

Courtney Duncan, BM, BSEE, MSEE, has worked as a communications, navigation, electronics, and software engineer since the early 1980s; has worked as a Cable TV Installer, climbing many poles and experiencing the hazards thereof firsthand. He has also worked in broadcast radio and TV in a variety of roles. He has been an amateur radio licensee since 1972 and has been active in many aspects of amateur radio including equipment construction, satellite management, emergency communications, public service, regulatory and policy matters, advanced operating modes, and software defined radios, among others. He is a former Vice President for Operations of the Radio Amateur Satellite Corporation, AMSAT-NA, and is employed at NASA's Jet Propulsion Laboratory where he now works on deep space navigation software. He is a member of IEEE, ARRL, and AMSAT-NA

4402 Rockmere Way
La Canada, Ca 91011

n5bf@amsat.org